Gantry Robotic Arm

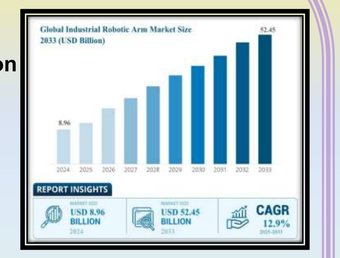
Automated handling function for users

Industry Group 12: Yuxuan Hu(2252551) Ruicheng Li(2253923) Zihan Xu(2253149) Bowen Duan(2253653)

User needs and design requirements

Background | Trends in Industrial Automation

- Rising Labor Costs
- Record-High Robot Density
- Manual Sorting Bottlenecks
- Accelerated Adoption of Automated Sorting Systems

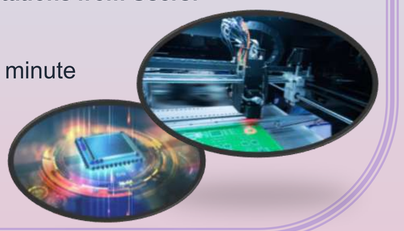


User Need | What Users Care About Most

- Cost-Effectiveness and ROI
- System Compatibility and Integration
- Stable and Reliable Performance
- Ease of Operation and Maintenance

Design Requirement | Practical Expectations from Users:

- **Precision:** ≤1 mm accuracy
- **Throughput:** ≥15 components/ 5 minute
- **High integration & adaptability**
- **Safety:** Emergency braking
- **Payload:** Up to 0.5 kg for motors

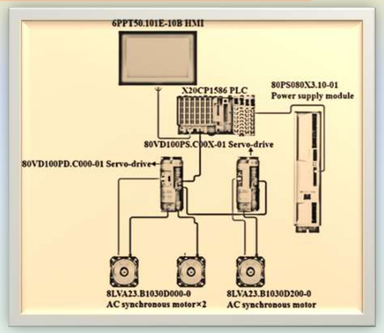


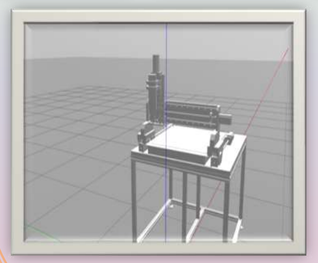
Hardware prototypes and software functions

Hardware prototype:

- PLC(XCP1586)
- Servo Driver
- AC synchronous motor
- HMI Screen
- Power supply module
- Photo-eyes
- Vacuum gripper
- Reasonable electrical connection

Set important control parameters in Automation Studio





Software function:

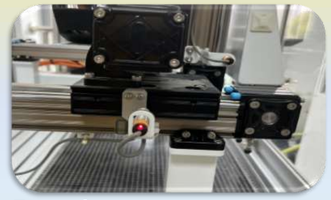
Initialization（based on ST and G code）:

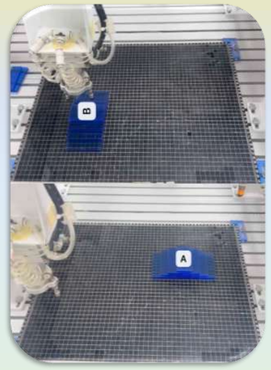
- Activating 3-axis control
- Configuration connection between software and hardware
- Automation code for robotic arms

ROS Simulation:

- Achieving communication through OPC UA
- Simulating mechanical architecture by URDF
- Simulating by Gazebo platform

Testing results and user feedback





Function

The robotic arm can complete:

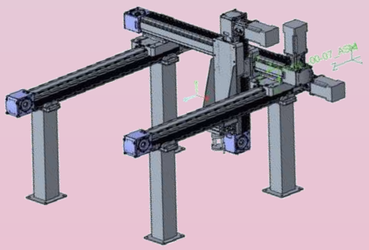
- constructing the pyramid.
- emergency braking.

Completely meet the users' need and design requirements.

- **Tester Zhang said:** Function is stable and accurate, can be available in practice. Design is fantastic!
- **Tester Xiao said:** Handles delicate chips and slides without damage.

Perfect for semiconductor labs!

Design features



- **----Automation**
- **----Industrial usage**
- **----Highly integration**
- **----High Compatibility**
- **----Modular Design**

- **----Precise & powerful** with 3-axis gantry with ±0.01mm accuracy, B&R servo motors
- **----Gentle Yet Firm** with Vacuum grippers
- **----Fail-Safe Safety** with photo-eye sensors & boundary limits
- **----Real-Time smart monitoring** Via ROS2 for predictive maintenance and remote oversight.

Contribution

Student Name/ID	Contribution percentage (100% in total)	Brief description of individual contribution
Bowen.Duan/2253653	25%	Conducting project background research and user need, Video and poster making, report writing
Ruicheng.Li/2253923	25%	PLC programming, testing, poster making and report writing
Zihan.Xu/2253149	25%	Configuring the electrical control part, simulating and debugging based on ROS2, poster making and report writing
Yuxuan.Hu/2252551	25%	Collecting user feedback, configuring the electrical control part, testing, poster making and report writing

Conclusion and future work

Conclusion

- Achieved high precision in pyramid stacking
- Gantry + servo system ensures reliable, repeatable motion.
- Vacuum gripper provides safe, adaptable component handling.
- Emergency stop and real-time monitoring enhance safety and control.
- Simulation-based development reduces prototyping cost and supports sustainability.

Future work:

- Generative AI for various functions
- Add 2D/3D cameras with YOLO model for more complex tasks
- Based on the ROS platform simulation, carry out better motion path planning.